thermoelectric pyrheliographs manufactured by Jules Richard in Paris.

The new Richard recording galvanometers (millivoltmeters) are, however, specially adapted for solarigraphs. By using coils with low resistance, approximately the same as that of the solarimetric piles, a marked increase in deflections was obtained. The sensitivity of the solarigraph is sufficient to get a deflection even with cloudy weather; characteristic variations are obtained on the diagrams, provided the thickness and transparency of the cloud changes.

In Figure 5 is shown a solarigraph record obtained on October 4, 1926, at the Solar Radiation Observatory of the U. S. Weather Bureau, American University, District of Columbia, where, through the courtesy of Professor Marvin, our solarigraph was calibrated. I am particularly indebted to Dr. H. H. Kimball, in charge of the Solar Observatory, and to his assistant, Mr. Irving F. Hand, for their kind help and very valuable suggestions during my stay at the observatory.

The record of October 4, 1926 (fig. 5); was obtained during a mostly clear day, although some clouds (visible between 12:30 and 1:30 p. m.) caused certain irregularities in the curve. Such a solarigram can be used for calculations, for instance, by planimetric methods, of the daily sums of solar and sky radiation on a horizontal surface.

Both direct-reading and recording solarimeters are made with two or more ranges, which permit the obtaining of greater deflections during cloudy or winter days with low sun. A very useful and important feature of the solarimeter is that it is able to give interesting records even on cloudy days, when the normal pyrheliometer gives no indication at all.

## NOTES, ABSTRACTS, AND REVIEWS

### WILLIS ISLAND METEOROLOGICAL STATION

A meteorogical station on an island so small and low and far to windward of large land masses that its climate is almost as purely marine as if the island were a ship is Willis Island in the south Pacific east of Australia. Willis Island lies 250 miles east of the north Queensland coast, approximately in latitude 16° S., longitude 15° W. Above ordinary seas it is less than 500 yards long and about 200 yards wide, and its summit is just under 30 feet above low water. Across it blows the southeast trade at a velocity that rarely is less than 5 m. p. h., and frequently is over 20 m. p. h. for long periods.

It is some six years since the Commonwealth Bureau of Meteorology established a station on the island. This was done largely to keep an eye on tropical cyclones approaching the coast of Australia. In addition to the usual surface observations, a series of pilot-balloon observations has made possible a preliminary analysis of free-air conditions in this trade-wind region. The following excerpts are adapted from a paper dealing with the seasons 1922–23 and 1923–24, by Dr. E. Kidson, entitled: "Observations from the Willis Island Meteorological Station," in volume 17 of the Report of the Australasian Association for the Advancement of Science, 1924 (the Government Printer, Adelaide, 1926).

To most people it is the winds of Willis Island that will be of greatest interest. Except for short breaks in the cyclone season, due either to passing cyclones or to the advent of the northwest monsoon, the southeast trade blows almost continuously, the mean direction being from southeast by east. In the six months November to April about 70 per cent of the winds are from between south and east, and in the winter months between 80 and 90 per cent. As far as the results go, they indicate that the wind velocity is greatest in the months when the pressure is rising, with a maximum in April, and least when the pressure is falling. The diurnal variation of the wind is especially interesting, since it can not be affected to any large extent by the land. * * * There is a maximum frequency of easterly winds in the hours just before sunrise. This is followed by a maximum for the east-southeasterlies in the three hours preceding noon. Thereafter the southerly component becomes more prominent, and south-easterly to southerly winds have their maximum frequency during the 16 hours to 18 hours period. In the northwesterly quadrant the winds tend to become more northerly in the forenoon hours and more westerly in the afternoon. * * *

The lowest velocity is recorded in the early afternoon, at about 14 hours or 15 hours. After sunset there is a fairly rapid increase to a maximum at about 22 hours to 23 hours.

The diurnal variation seems to consist chiefly, therefore, in the production of an easterly component in the morning and a westerly in the afternoon. The mean velocity is 15.7 miles per hour (7.1 meters per second). * * *

Pilot balloon ascents were made once daily during the seasons 1922–23 and 1923–24. Among the first points noted with regard to the ascents are the small change in direction with height and the low height at which a maximum velocity is reached. * * * It must be remembered that for the upper levels results are available for clear days and days of light wind only, and consequently they may not represent mean conditions. It is unlikely, however, that the impressions they give are very misleading. Above 1 km. the direction gradually becomes more variable, southerlies and westerlies being more frequent. Above 4 km. it would seem that southwesterlies prevail, while at still higher levels it is most probable that northwesterlies are the most frequent. At the high levels winds from the northeasterly quadrant are the least frequent.

The winds do not in every case veer in the lower levels from the surface direction. In fact, the ratio of the number that back to the number that veer between 50 m. and 450 m. is 1 to 1.8. This ratio was obtained in both seasons, and is the same for winds of all types. The reason for this constancy is not clear. The northwesterly winds veer to a greater extent than the southeasterly.

Such evidence as there is tends to show that in general the velocities begin to fall off before 1 km. is reached and continue to do so over the range covered by the balloon ascents. Strong winds are rare, the strongest gusts recorded on the surface being about 18 m/s (40 m. p. h.). Velocities greater than this were only rarely met with in the first kilometer above the surface, though 29 m/s (65 m. p. h.) was reached on one occasion. Were a cyclone to approach very near the island these speeds would, of course, be greatly exceeded.—*B. M. W.*

### THE CAUSES OF GLACIATIONS

551.532(048)

In a review of Prof. A. P. Coleman's "Ice Ages: Recent and Ancient" (Macmillan, 1926), C. E. P. Brooks writes as follows (in *Nature*, London, August 28, 1926), touching the far-from-solved problem of the causes of glaciations:

* * * These phenomena offer a definite meteorological problem, which the author sets out clearly in words which are worth quoting:

"Under normal conditions the world has a relatively mild and equable climate with no permanent ice at low levels even in the polar regions.

"From time to time * * * there have been relatively short periods of cold accompanied by a great extension of mountain glaciers, and sometimes also by the formation of ice sheets at low levels. In the most severe visitation of the kind ice sheets invaded the Tropics on three or perhaps four continents.

"Ice ages are, in most cases, broken by interglacial periods of milder climate. Sometimes this occurs two or three or more times, indicating a comparatively rapid oscillation from cold to warm and warm to cold.

"All parts of the world have their temperature lowered during an ice age, the Tropics as well as the temperate and Arctic zones."

The author then turns to the consideration of causes, but gives only a rather mechanical discussion of the various theories of climatic change which have been put forward from time to time. Wegener's theory of continental drift is mentioned, but without